On the role of tasks in virtual game-based learning: The example of “Lost in Antarctica“

Simone Kibler
Technische Universität Braunschweig (Germany)

Linda Eckardt
Technische Universität Braunschweig (Germany)

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Simone Kibler/Linda Eckardt

Dr. Simone Kibler

University Library

Universitätsplatz 1

38106 Braunschweig

Germany

s.kibler@tu-braunschweig.de

Linda Eckardt

Institute of Business Information Systems

Mühlenpfordtstraße 23

38106 Braunschweig

Germany

linda.eckardt@tu-braunschweig.de

Abstract

There is evidence that tasks play an important role in the context of the development of virtual learning scenarios. This paper will focus on this fact and identify the relationship between tasks and their purpose in the context of “Lost in Antarctica”. This game-based blended-learning scenario contains a huge variety of tasks ensuring the acquisition of different skills within the broad range of information literacy (IL)-topics. In conclusion, general recommendations for the use of tasks in the conceptional process of e-learning environments should be given.

"Lost in Antarctica" is a game-based blended-learning platform for about 150 students of Industrial Engineering and Management who receive credit points for the successful completion of 12 levels representing important topics of IL. The source code of the game is available for all interested institutions. In the story-based learning scenario, the students act as scientists who travel in teams on a research expedition to the South Pole, but due to a snow storm they crashland. For the completion of each level, an airplane component can be received to repair the defective airplane. In the game, each level has a similar structure: the students have to alternately acquire knowledge and solve tasks. Opening new and innovative ways for teaching IL, the University Library of Braunschweig, the Institute of Business Information Systems (Department Information Management) of the Technische Universität Braunschweig and further strategic partners from university libraries in Hannover and Clausthal (Germany), developed this game-based blended-learning module on IL. During the creation process of the game, students as representatives of the target group were involved in the creation of the story and in the development of the ranking criteria for the game through several student innovation projects.

Keywords: information literacy, information literacy teaching, gamification, game-based learning, blended learning, higher education

Information literacy (IL) in Germany

IL can be seen as one of the key competencies for 21st century learning. Its impartation is one of the major working fields involving academic libraries in Germany, and Meyer-Doerpinghaus even points out that it is a central component of scientific information infrastructures (Meyer-Doerpinghaus, 2016, p. 200). Although there are currently considerations to redefine the term in Germany (see Sühl-Strohmenger, 2016), practice-oriented work definitions exist that can be used as a basis for the design of IL classes and the associated definition of learning objectives. P21 provides such a helpful working definition. According to P21, IL includes the ability to access information efficiently and effectively as well as to evaluate information critically and competently. Furthermore, you should be able to use information accurately and creatively for the issue or problem at hand and manage the flow of information for various sources while considering ethical and legal issues surrounding the access and use of information (Partnership for 21st Century Learning). The German Library Association (2009) has defined standards of IL earlier which serve as the basis for work at the University Library of Braunschweig and are in accordance with the aforementioned definition. Following the ideas of this association, information literate students should be able to

- "identify and articulate their need for information and determine its' type and extent (…),
- efficiently access the needed information (…),

- evaluate the information and sources they retrieved, and select them according to their needs (…),
- process the retrieved information effectively and convey it tailored to the needs of the target group using appropriate technical tools (…) and
- take on responsibility for their information use and transmission of information (…)" (Deutscher Bibliotheksverband e. V., 2009, pp. 3–4).

The University Library Braunschweig teaches the full range of IL topics, although the specific course content may vary depending on the target group (e. g. students, postgraduates, academic staff) and on their subject of study or research. Course offers linked to the curricula of the subjects are available as well as noncurricular offers. In any case, close cooperation with the departments or institutes takes place in order to be able to completely fulfill their content requirements. In 2016, the University Library Braunschweig was asked to create a new curricular course module on IL for approximately 250 students of Industrial Engineering and Management in the Faculty of Mechanical Engineering of the Technical University (TU) Braunschweig, starting in the winter semester of 2016/17. Students will receive a study certificate and two credit points for their obligatory participation. Against this background, the University Library took the opportunity to test new ways of conveying IL and launched a cooperative project with two other university libraries located in the region, Hannover and Clausthal. The goal was to develop a blended-learning game-based scenario on IL for the above-mentioned target group. The technical implementation of the project was carried out by the Institute of Business Information Systems of the Technical University Braunschweig, whose staff provided the required gaming expertise. In the following, we will take a closer look at the resulting serious game “Lost in Antarctica”.

“Lost in Antarctica” - a game-based learning scenario for the impartation of IL

When a game-based learning application is planned, two options are available: gamification and serious games. While gamification is the integration of a few game elements, a serious game entails the development of a full-fledged game with fixed rules and goals (Deterding, Dixon, Khaled, & Nacke, 2011, p. 11). Although these two forms of game-based learning cannot always be clearly distinguished, they have one thing in common: the use of game elements. The objective is to make learning more fun and to lead to a more intensive exploration of the learning content (Kapp, 2012, pp. 76–103). It was decided to develop a serious game in the form of a point-and-click browser game. The reason for this was that while no teaching concept existed that could be adapted, the learning content and goals were already defined. The game was created with its target group, the students, to ensure the development of a learning environment that enables the students to learn while having fun (Boller & Kapp, 2017, pp. 101–102). Figure 1 shows two screenshots of the game in which students travel to Antarctica as teams of scientists on a fictional research expedition.

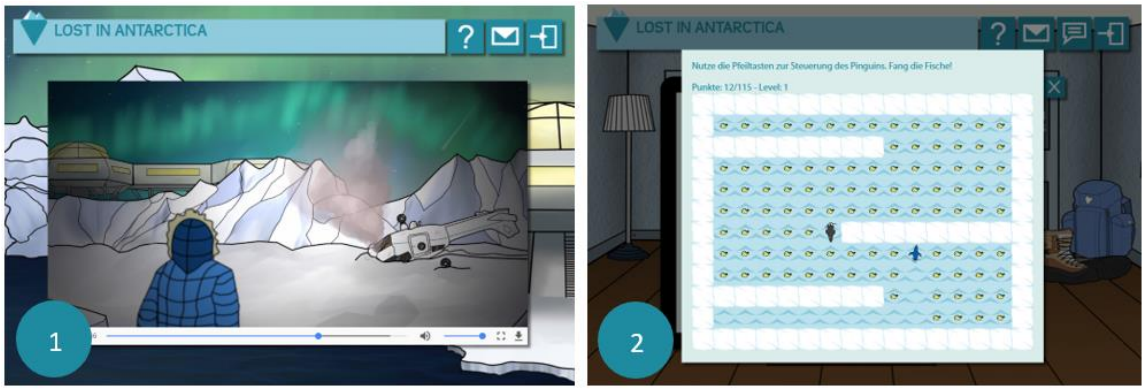

Figure 1: Screenshots of “Lost in Antarctica”

Their plane crashes due to a blizzard (screen 1). Therefore, in addition to their research, they have to repair the defective aircraft. Within twelve levels, each covering a subject area of IL (e.g. research strategies, scientific writing and literature management), students learn how to use information efficiently. Each level is structured identically: students have to complete a checklist, and there is some kind of knowledge acquisition (e.g. videos and presentations) and some kind of knowledge testing through different task types. Students can earn up to 300 points in each level, but only need 200 points to successfully complete it. All points above 200 can be exchanged for mini-games (e.g. Pengman, screen 2, based on the traditional Pacman game) which are integrated for fun and entertainment purposes only. For each successfully completed level, students receive a component to repair the aircraft. Thus, these components represent the progress in the game. In addition, duplicate components can be exchanged with other teams on an exchange platform and an individual and a team ranking allow the comparison among each other (Eckardt & Robra-Bissantz, 2016, pp. 202–203). The next section offers a theoretical framework for a closer examination of the role of tasks in the game.

Theoretical framework: *constructive alignment* (John Biggs)

In the following, the theory of *constructive alignment* as set out by Biggs (1999) is introduced, since this allows us to work out the role of tasks in the teaching-learning process and to reflect their importance in “Lost in Antarctica” (for an introduction in German see Kibler, 2017). Biggs aligns learning objectives, teaching/learning activities (TLAs) and assessment based on constructivist assumptions (introductory see Reich, 2012). The three aspects play a pivotal role in the course design process, emphasizing the importance of student activity. With regard to the design process, Biggs firstly recommends specifying learning objectives, secondly implementing adequate assessment tasks that are “criterion-referenced” to the learning objectives, and thirdly using appropriate TLAs “that encourage students to go about learning in a way that is likely to achieve our objectives” (1999, pp. 63–64). He later clarifies that “in a criterion-referenced system, the objectives are embedded in the assessment tasks” (Biggs, 1999, p. 68). Biggs’ theory also offers a starting point for the incorporation of different levels of knowledge processing into course design considerations. He arranges different levels of knowledge

processing along a hierarchy of different verbs, which can be included in the wording of learning objectives. Hierarchy level A (to identify, to do simple procedures) has the lowest processing depth, while hierarchy level D has the highest processing depth. Biggs underlines: “Major objectives would refer to at least relational levels of understanding, where students are not only expected to know facts and information, but to structure them in forms that can be applied to common problems and domains. By the end of professional training, students should be extending knowledge to hitherto unseen problems and domains” (Biggs, 1999, pp. 66–67). TLAs describe a teaching/learning context that is meant to encourage students to “react with the level of cognitive engagement that the objectives require” (Biggs, 1999, p. 67). Biggs distinguishes between teacher-controlled (e. g. lecture, tutorial, seminar, …), peer-directed (e. g peer-teaching, collaboration, learning partners, …) and self-directed activities (content study skills, metacognitive learning skills, …) (see 1999, p. 68). Even more important in the present context are assessment tasks. According to Biggs, “[c]riterion-referenced assessment in the constructive alignment model requires assessment tasks that are likely to elicit the learning verbs that are stipulated in the objectives” (1999, p. 70). He lists different task types and the associated processing depth like the essay-type of tasks, objective tests, performance assessments and rapid assessments. Constructive alignment thus is an important framework that was kept in mind during the conceptualization phase of “Lost in Antarctica”. The next paragraph will provide further details on tasks in e-learning and tie these together with *constructive alignment*.

Tasks and feedback in digital game-based learning

Following Meder and Frick (2006), tasks are interactive types of knowledge that firstly give background information on the defined problem. Secondly, so-called blanks are produced which the learner has to fill in throughout the activity. The authors additionally point out that tasks have two important functions: the generation of knowledge and the testing of knowledge and skills. In the context of web didactics, tasks are essentially regarded as learning tasks. With the right solution to learning tasks, a learning objective is achieved, which is then verified in a self-test and tested in a final test. If what has been learned can then also be transferred, the desired competence has been achieved (Frick & Meder, 2006, pp. 72–73). Vai and Sosulski (2016) specify that “assessment is clearly and directly tied to the learning outcomes of the course” (Vai & Sosulski, 2016, p. 150). This view shows close connections to *constructive alignment* according to Biggs. At the beginning of a conceptual process it is important to deal with different types of tasks in order to be able to use them purposefully. Mayer et al. (2009) propose to divide task types according to the form of the possible answer (e.g. checking, assigning, rows, selecting, etc.). Following this viewpoint, the standard types for checking learning objectives listed here would be: yes/no-tasks, single/multiple choice tasks, marking tasks, sequence tasks, assignment tasks (assignment of terms, images etc., shaking sentences), crossword puzzles and text tasks (gap text, free text) (Mayer et al., 2009, p. 79). Each type of task is in relation to

the learning objective and is in a certain way suitable for checking it. The following table shows the relationship between task types and processing depth of knowledge according to Biggs theory of *constructive alignment* (table 1):

Table 1: Task type and purpose, knowledge processing depth

Task type	**Task purpose (Mayer et al., 2009, pp. 78–95)**	**Processing depth in *constructive alignment* (Biggs, 1999, p. 67)**
Yes/no-tasks	Reproduction of factual knowledge and conceptual knowledge, possibly more complex learning objectives	A (identify, do simple procedure) B (enumerate, describe, list, combine, do algorithms) C (compare/contrast, explain causes, analyze, relate, apply)
Single choice task	Reproduction of factual knowledge and conceptual knowledge, possibly more complex learning objectives	A to C
Multiple choice task	Review of many dimensions of learning objectives	A to C
Marking task	Identification, transfer	A to C
Sequence task	Recording of connections and differences of terms or elements, good recording of structures	A to C
Assignment tasks	Reproduction and application of knowledge	A to C
Crossword puzzle	Reproduction of knowledge, in the presence of a concept also application of knowledge	A to C
Gap text	Reproduction and application of knowledge	A to C
Free text	Development of own ideas and concepts, independent structuring and formulation of contents	D (theorize, generalize, hypothesize, reflect)

An extension of this view that sees tasks as test tasks can be found in Arnold et al. (2018, p. 135),who emphasize that learning tasks should not (only) be test tasks, but encourage learning activities, like for example cooperative learning: “Cooperation in groups promote key social qualifications (…), and exchange of different perspectives contributes significantly to an intensive discussion of those areas of knowledge that require special spiritual penetration. Eventually, clearly positive motivational effects can be seen, which (…) are associated with an increased learning intensity and persistence, as well as a lower abortion rate” (Kerres, 2002, p. 4). Following this point of view, cooperative learning can promote a high processing depth of knowledge and thus, as in the sense of Biggs' theory, can be used as a meaningful supplement to the just listed, non-cooperative task types (for further information on cooperative learning on the internet see (Meder, 2006, pp. 86–118). Furthermore, research has shown that in extensive e-learning courses with a lot of learning content and tasks, a variety of methods and technical implementation is important to avoid boredom and rejection of the e-learning course. Monotonous and recurring task types do not motivate the learner to become interested in the learning content (Frank, 2012, p. 159). Nevertheless, the tasks should not be randomly varied and enriched by effects. This can be ineffective or even disadvantageous, as the learners underestimate the difficulty of the tasks and, as a consequence, make less of an effort to solve the tasks (Weidenmann, 2011, p. 82). The tasks should therefore mainly draw attention to the learning material and arouse interest in its content. Through the implementation of a meaningful design, solving tasks can result in a way of learning that participants enjoy (Frank, 2012, p. 159). Research results show that the use of many different types of tasks that are purposefully designed to achieve learning objectives has a positive effect on the learner’s attitude towards the learning object and increases the motivation to learn (Olney et al., 2015). But tasks are only one side of the coin. That is why it is necessary to focus on the function of feedback in learning processes. Feedback can be seen as a crucial element in online learning (Foley-McCabe & Gonzalez-Flores, 2017, pp. 254–259; Vai & Sosulski, 2016, pp. 154–159). Vai and Sosulski clarify the function of feedback as follows: “[T]he role of feedback is to: expand upon the learner's knowledge; help the learner understand how to improve and progress within the course; address misconceptions and misunderstandings, and correct mistakes; and motivate learners by promoting a positive attitude toward the challenges of the activity and their progress in it” (Vai & Sosulski, 2016, p. 154, formatting of the original not adopted, S. K.). It should be given frequently and timely, be specific and offer personalized support, it should invite action and can be given either by learners (peer to peer feedback) or by teachers (Foley-McCabe & Gonzalez-Flores, 2017, pp. 254–259). Peer feedback can be distinguished by the symmetrical relationship between the encoder and recipients from lecturer and tutor feedback (Schulz, 2013, p. 28). Learners can profit from peer feedback (for an overview see Lu & Law, 2012). They might have the feeling that their work is not only relevant to the teacher, but also to a larger audience. Furthermore, they develop assessment skills which could lead to self-reflection on their own work. Lastly, a wider variety of perspectives on the topic might lead to a deeper understanding (see Vai & Sosulski, 2016, p. 155). Additionally, Schulz stresses that

peer feedback allows learners to play a more active role in the learning process and control it (2013, p. 28). Thus peer feedback can have an added value in comparison to teacher feedback and should therefore be implemented through the corresponding task types. In the next section, the role of tasks and feedback in “Lost in Antarctica” is examined in more detail.

Tasks and feedback in “Lost in Antarctica”

In the serious game, knowledge is tested through various task types after knowledge transfer has taken place. All of the aforementionned task types and cooperative tasks requiring peer feedback were implemented into the game. The following screenshots (figure 2) show the task types integrated in the game. An example for yes/no-tasks (screen 1) would be a question that asks students to decide whether a quotation is correct or whether the procedure for copying text passages from other papers in their final thesis is legal under copyright law. Screen 2 shows the design of single and multiple choice tasks in which learners for example need to know the difference between Google and Google Scholar. In the marking tasks (screen 3), students have to mark results that would be retrieved with a certain search query to demonstrate their proficiency in using Boolean Operators. Sequence tasks are included in the serious game as well. For example, students have to sort search results (screen 4) according to scientific criteria. Furthermore, different assignment tasks are included: shaking sentences (screen 5) in which students have to develop a meaningful search query on a certain topic are integrated as well as tasks in which students have to assign images (screen 6) or terms (screen 7). Crossword puzzles (screen 8) where students have to search the internet for solutions are also included. Understanding of terms, for example criteria for checking scientific suitability, is practiced with the help of gap texts (screen 9). Cooperative tasks, appearing in different kinds of visual presentations (screen 10), allow students to vote on case studies within their teams and formulate justifications based on copyright law. While completing other tasks, students have to upload their solutions on the learning platform and get an evaluation by other students through peer assessment, like in the level “literature management”. To ensure that given answers are really correct, the teacher’s solution is given to all students after the completion of the task and the review. Even though the quality of the evaluation is not identical to that of teachers, this procedure ensures faster feedback for the students and offers a review and application of the learned skills by evaluating the answers of other students.

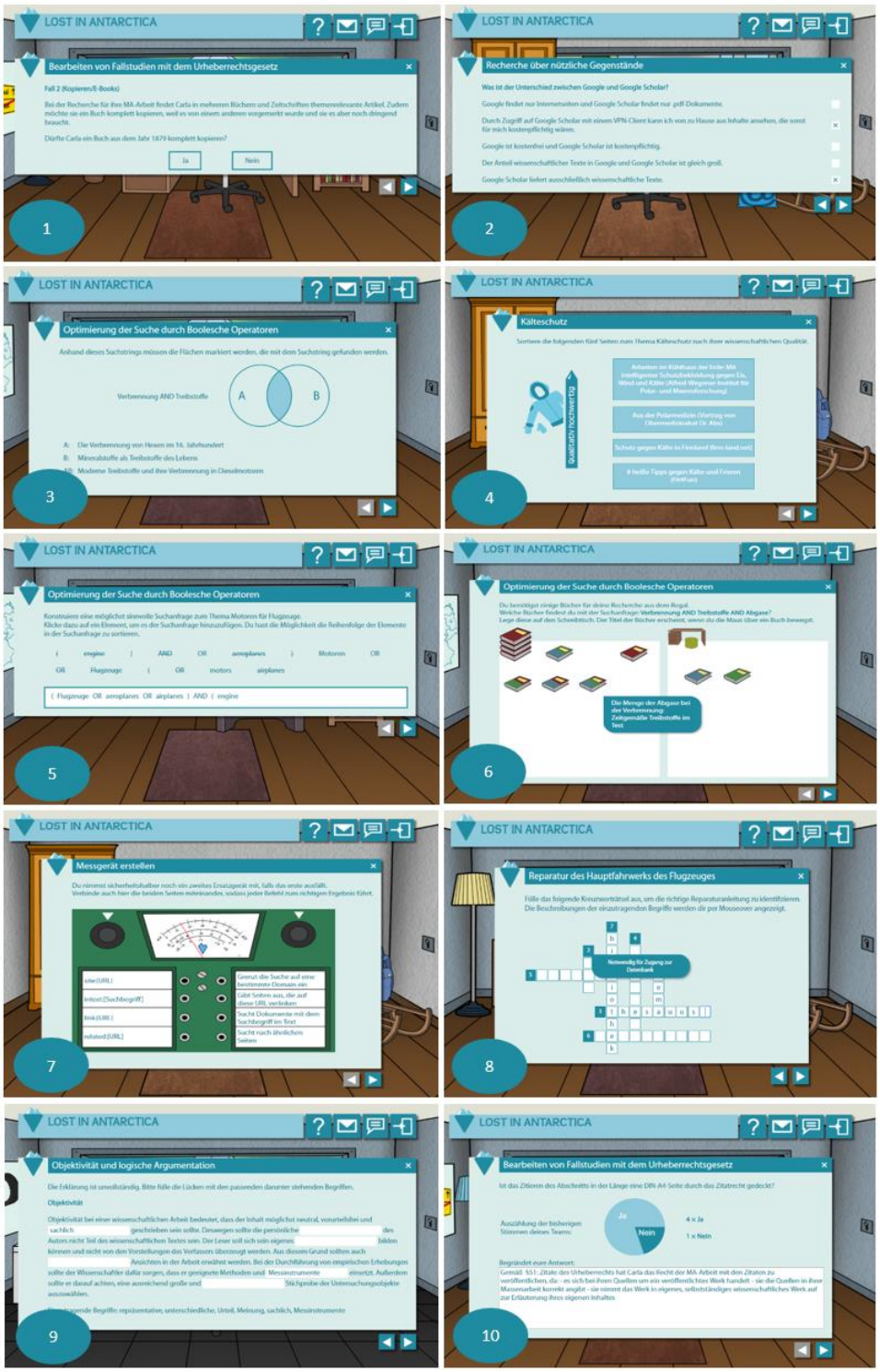

Figure 2: Different task types in “Lost in Antarctica”

After describing the variety of tasks in our serious game, the final remarks follow in the next section.

Conclusion

Imparting IL is an important working field for academic libraries, and specific subject requirements from institutions interested in cooperation with libraries open new ways of impartation. Not only to meet the content specific requirements of the Faculty of Mechanical Engineering but also to make learning more interesting and motivating for the students, the University Library decided to introduce game-based learning in the field of IL instruction. C*onstructive alignment* provides a helpful theoretical framework to design and evaluate course programs by classifying the processing depths of knowledge in relation to certain task types. Along this theory, it was shown that common task types supplemented by free text tasks cover all knowledge processing steps according to Biggs (1999). Furthermore, scientific findings have shown that tasks in general and especially different types of tasks play a central role in online learning settings and that a huge variety of learning tasks has a positive effect on motivation and fun. Cooperative learning and peer feedback can be seen as elements that complement learning tasks in a meaningful way and, like free-text tasks, enable a deeper understanding of the learning object. For these reasons, “Lost in Antarctica” not only provides a huge variety of tasks addressing different knowledge processing depths according to Biggs theory of *constructive alignment* in order to maximize students’ motivation and learning success. It also includes cooperative tasks and the opportunity for the learner to receive peer feedback. The future will show to what extent the learning situation of students really improves through this new way of teaching.

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